CHAPTER 1
CONCEPTS OF RADIOLOGIC SCIENCE

NATURE OF OUR SURROUNDINGS

Matter
- Anything that occupies space & has mass

Atoms
- The building blocks of matter

Mass
- The quantity of matter as described by its energy equivalence
- The distinguishing characteristic of matter

Weight
- The force exerted on a body under the influence of gravity

MATTER AND ENERGY

Matter
- Material substance with mass of which physical objects are composed

Atoms & Molecules
- The fundamental, complex, building blocks of matter

Energy
- The ability to do work
- *SI Unit:* joules (J)
- *In Radiology:* electron volt (eV)

Potential Energy
- The ability to do work by virtue of position

Kinetic Energy
- The energy in motion

Chemical Energy
- The energy released by a chemical reaction

Electrical Energy
- The work that can be done when an electron moves through an electric potential difference (V)

Thermal/Heat Energy
- The energy in motion at the molecular level

Nuclear Energy
- The energy that is contained within the nucleus of an atom

Electromagnetic Energy
- The type of energy that is used in an x-rays

Theory of Relativity
- Albert Einstein
- States that matter and energy are interchangeable

Matter-Energy Equivalence
- *Formula:* $E=mc^2$

Radiation
- The energy emitted & transferred through space

Visible Light
- Radiated by the sun

Exposed/Irradiated
- Matter that intercepts & absorbs radiation

UV Light
- It causes sunburn

Ionizing Radiation
- Any type of radiation that is capable of removing an orbital electron from the atom with which it interacts
- *Examples:* x-rays, gamma rays & UV light

Ionization
- The removal of an electron from an atom

Particulate-type Ionizing Radiation
- *Examples:* alpha & beta particles

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SOURCES OF IONIZING RADIATION

Natural Environmental Radiation
- *Annual Dose:* 300 mrem/yr
- *Cosmic Rays:* emitted by sun & stars
- *Terrestrial Radiation:* deposits of uranium, thorium & other radionuclides
- *Internally-deposited Radionuclides:* potassium-40 (natural metabolites)
- *Radon:* largest source

Man-made Radiation
- *Annual Dose:* 60 mrem/yr
- *Diagnostic X-rays:* largest source (39 mrem/yr)

NCRP
- National Council on Radiation Protection & Measurements

MSCT
- Multislice Spiral Computed Tomography

Medical Applications of Ionizing Radiation
- *Annual Dose:* 50 mrem/yr

DISCOVERY OF X-RAYS

Cathode Rays
- Electrons

Sir William Crookes
- He invented crookes tube

Wilhelm Roentgen
- He discovered x-rays

November 8, 1895
- Discovery of x-rays
- Wurzburg University in Germany

Barium Platinocyanide
- The fluorescent material used by Roentgen

Fluorescence
- The emission of visible light only during stimulation

1901
- Roentgen received Nobel Prize in Physics

February 1896
- He published and produced the first medical x-ray image
- The first x-ray examination

DEVELOPMENT OF MODERN RADIOLOGY

Radiography
- Uses x-ray film & x-ray tube mounted from the ceiling
- Provides fixed images

Fluoroscopy
- Conducted with an x-ray tube located under the examination table
- Provide moving images

X-ray Voltage
- Measured in kVp

To provide an x-ray beam that is satisfactory for imaging, you must supply the x-ray tube with a high voltage & sufficient electric current!

X-ray Current
- Measured in mA

Image Blur
- *Caused:* long exposure time

Michael Pupin (1896)
- He demonstrated the use of radiographic intensifying screen

Charles L. Leonard (1904)
- He demonstrated the use of double emulsion film

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Thomas A. Edison (1898)
- He developed fluoroscope
- *Original Fluorescent Material:* Barium platinocyanide
- *Most Recent:* Zinc cadmium sulfide & calcium tungstate

Clarence Dally (1904)
- The first x-ray fatality

William Rollins
- He demonstrated the first application of collimation & filtration

H.C. Snook (1907)
- He introduced interrupterless transformer
- Snook transformer

William D. Coolidge (1913)
- He introduced coolidge x-ray tube

Radiology emerged as a medical specialty because of the snook transformer & the Coolidge x-ray tube!

Gustav Bucky (1913)
- He invented stationary grid
- "*glitterblende*"

Hollis Potter (1915)
- He invented moving grid

1921
- Potter-Bucky grid was introduced

Light Amplifier (1946)
- He demonstrated at Bell Telephone Laboratories

1950
- Light amplifier was adapted for fluoroscopy

1960
- Diagnostic UTZ & gamma camera appeared

1970
- PET & CT were developed

1980
- MRI become an accepted modality

MEG
- Magnetoencephalography

Because of effective radiation protection practices, radiology is now considered a safe occupation!

Always practice ALARA: keep radiation exposures As Low As Reasonably Achievable!

Filtration
- It absorbs low energy x-rays
- Aluminum or copper

Collimation
- It restricts the useful x-ray beam
- It reduces scatter radiation
- It improves image contrast
- *Example:* adjustable light-locating collimators (common)

Intensifying Screen
- It reduces x-ray exposure by more than 95%

Protective Apparel
- Lead-impregnated material
- *Examples:* gloves & apron

Gonadal Shielding
- It is used with all persons of childbearing age

Protective Barriers
- Lead-lined with a leaded-glass window
- *Example:* radiographic control console

ARRT
- American Registry of Radiologic Technologists

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TEN COMMANDMENTS OF RADIATION PROTECTION

1. Understand & apply the cardinal principles of radiation control: time, shielding & distance.
2. Do not allow familiarity to result in false security.
3. Never stand in the primary beam.
4. Always wear protective apparel when not behind a protective barrier.
5. Always wear an occupational radiation monitor and position it outside the protective apron at the collar.
6. Never hold a patient during radiographic examination. Use mechanical restraining devices when possible. Otherwise, have parents or friends hold the patient.
7. The person who is holding the patient must always wear a protective apron and, if possible, protective gloves.
8. Use gonadal shields on all people of child bearing age when such use will not interfere with the examination.
9. Examination of the pelvis and lower abdomen of a pregnant patient should be avoided whenever possible, especially during the first trimester.
10. Always collimate to the smallest field size appropriate for the examination.